

DatAR: An Immersive Literature Exploration Environment for Neuroscientists

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Abstract—Maintaining an overview of publications in the neuroscientific field is challenging, especially with an eye to finding relations at scale; for example, between brain regions and diseases. This is true for well-studied as well as nascent relationships. To support neuroscientists in this challenge, we developed an Immersive Analytics (IA) prototype for the analysis of relationships in large collections of scientific papers. In our video demonstration we showcase the system’s design and capabilities using a walkthrough and mock user scenario. This companion paper relates our prototype to previous IA work and offers implementation details.

Index Terms—Immersive analytics, augmented reality, linked data, literature exploration, neuroscience

I. INTRODUCTION

The more papers are published, the harder it becomes for neuroscientists to maintain an overview. While literature reviews serve to defragment contributions, manual review is costly and – even when performed rigorously – researchers run the risk of missing important perspectives not identified at some part of the review process [1].

Talking with neuroscientists at the Institute of Automation of the Chinese Academy of Sciences, we found that one of the main shortcomings of manual literature exploration lies in performing complex relation-finding (Cunqing Huangfu, personal communication, June 12, 2019; July 3, 2019). Without automated tools, it would be hopeless to find out which brain region is most often referenced when discussing, e.g., depression – indicating wide consensus on this relationship. Likewise, it would not be possible to find out which brain regions are mentioned only seldom – which could offer fruitful grounds for further investigation.

On both the computational and visualisation side (cf. [2], [3]), computer scientists have addressed the need for a distant reading approach to academic literature. We are not aware that any such system has yielded significant user adoption, however. More work is required to make tools directly accessible to neuroscientists (without the need for a supporting data analyst), and to integrate these in existing research workflows.

With the end goal of supporting neuroscientists in performing complex relation-finding tasks through human-in-the-loop analytic, DatAR (*Data exploration in Augmented Reality*) combines neuroscientific knowledge graphs with an Immersive

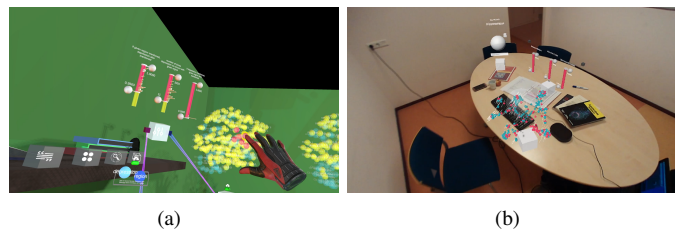


Fig. 1. (a) User scenario: a neuroscientist filters a visualised brain model based on co-occurrences in the literature of each brain region with “depression,” (b) early augmented reality version of the system.

Analytics (IA) approach. We present a functional prototype and scenario that draws from the design work in our earlier research proposal [4]. Our prototype uniquely contributes to the design space where literature exploration and IA overlap. In our video demonstration we showcase the system’s design and capabilities through a walkthrough and mock user scenario. A full paper with detailed design considerations and an evaluation of the system is forthcoming, in which the currently presented video demonstration was used in adapted form to gauge willingness to adapt AR technology in daily work practices.

II. RELATED WORK IN IA

DatAR differentiates itself from previous work in literature exploration by focusing on the analytics experience *in Augmented Reality*. While Visual Analytics has become a mainstay in human-in-the-loop data analysis, IA attempts to move analytics tools from the 2D screen into our environment (both in Virtual and Augmented Reality; for a survey of the field, see [5]). The aim is to design “engaging, embodied analysis tools to support data understanding and decision making [and] liberate these activities from the office desktop” [6, p.14–15].

IA research has its roots in the use of large curved wall displays (CAVEs). However, findings by [7] suggest that modern head-mounted displays (HMDs) have caught up by being both more cost-effective and allowing faster analysis without sacrificing accuracy. Moreover, HMDs output binocular imagery, aiding depth perception. Given that affordance,

a key consideration is whether to map data to 2D or 3D space. Any use of the third dimension has long received strong scepticism within the information visualisation community due to the added visual complexity [6], but there is now a renewed interest in critically re-assessing *binocular* 3D visualisations. As every reduction of an n -dimensional space (e.g., of a topic model) translates to data loss [8], our project intends to re-evaluate the merits of 3D information visualisation.

Finally, there are also several academic toolkits available in the area of IA, such as DXR [9] and IATK [7], based on such works as ImAxes [10]. However, these frameworks were developed with quantitative data in mind. While the database that DatAR uses contains some numerical data, its most important features are its relationship topology and the text it contains. Graphs and text require different visualisation strategies, which is why we have opted to develop our system from the ground up with this in mind, rather than adopt and work around an existing framework.

III. DESCRIPTION OF SCENARIO

Our video demonstration (previewed in Figure 1) consists of two main parts¹. We first offer a tutorial series that explains the representation and interaction design of the system. We then showcase a mock scenario with a neuroscientist, Stu, who aims to investigate the relationship between two brain disorders: depression and anxiety. Stu relates these two disorders with brain regions that have often been co-mentioned in the literature to determine a fruitful next area of (empirical) research. Using a visualised brain model, topic model of diseases, and web interface with source sentences, he determines that the amygdala would be an interesting brain region to further look into. The scenario is not fully scripted, and serves to show the system’s capabilities when given a concrete use case. The paper shown as a starting point in the scenario is [11].

IV. IMPLEMENTATION

We used Unity² (v2019.3.9f1) to build our main interface. Dataflows were implemented using a reactive framework, UniRx³ (v7.1.0), which allows for live-processing of data changes. The AR version of the system was built using the Meta SDK (v2.7.0.38) to support the Meta 2 HMD, optionally using Leap Motion for hand-tracking. The VR version of the system was built on SteamVR (v2.5; SDK v1.8.19)⁴.

A companion web application was developed in Angular⁵ (v8.2.14) to allow the main environment to send text-heavy content to a screen for easier reading than AR currently allows. To coordinate this communication, we used a RabbitMQ⁶ (v3.8.2) instance as a message broker.

The internal data structure in both the Unity and Web interfaces follows the guidelines of the JSON-LD standard⁷,

and is easily exported as such. This way we preserve the linked data nature of the source database and allow easier integration with external platforms.

V. DISCUSSION & CONCLUSION

We developed DatAR, a prototypical IA environment for literature exploration. In our video demonstration, we propose a novel visual data representation for linked data concepts as well as a widget-based visual dataflow interaction model that ties together tasks such as querying, manipulation, visualisation and export of data.

We will continue to use DatAR as a tool to explore whether augmented reality, and IA in general, could offer a good fit to support scientists in performing their literature reviews more effectively. To this end, we will continue to conduct user studies in AR/VR to analyse user experience as well as conduct broadly targeted scenario-based surveys to better understand requirements and willingness to integrate IA in existing work processes.

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¹Also accessible via https://youtu.be/PnOPECRNc_w

²<https://unity.com/>

³<https://github.com/neuecc/UniRx>

⁴In the latest version of DatAR (v2020.1.1), only SteamVR is supported.

⁵<https://angular.io/>

⁶<https://rabbitmq.com/>

⁷<https://json-ld.org/>